



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>7</sup> : <b>A61K 31/41, 31/135, C07D 257/04, C07C 255/00</b>	<b>A1</b>	(11) International Publication Number: <b>WO 00/45816</b> (43) International Publication Date: <b>10 August 2000 (10.08.00)</b>
(21) International Application Number: <b>PCT/US00/02676</b> (22) International Filing Date: <b>2 February 2000 (02.02.00)</b> (30) Priority Data: <b>60/118,240</b> <b>2 February 1999 (02.02.99)</b> <b>US</b> (71) Applicant (for all designated States except US): <b>SMITHKLINE BEECHAM CORPORATION [GB/GB]; One Franklin Plaza, Philadelphia, PA 19103 (GB).</b> (72) Inventor; and (75) Inventor/Applicant (for US only): <b>LAGO, Amparo, M. [ES/US]; 701 Pondview Drive, Audubon, PA 19406 (US).</b> (74) Agents: <b>SIMON, Soma, G. et al.; SmithKline Beecham Corporation, Corporate Intellectual Property, UW2220, 709 Swedeland Road, P.O. Box 1539, King of Prussia, PA 19406-0939 (US).</b>		(81) Designated States: <b>AE, AL, AU, BA, BB, BG, BR, CA, CN, CZ, EE, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KP, KR, LC, LK, LR, LT, LV, MA, MG, MK, MN, MX, NO, NZ, PL, RO, SG, SI, SK, SL, TR, TT, TZ, UA, US, UZ, VN, YU, ZA, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</b>  Published <i>With international search report.          Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
(54) Title: <b>CALCILYTIC COMPOUNDS</b> (57) Abstract <p>Novel calcilytic compounds are provided.</p>		

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## CALCILYTIC COMPOUNDS

### FIELD OF INVENTION

The present invention relates to novel calcilytic compounds, pharmaceutical compositions containing these compounds and their use as calcium receptor antagonists.

5 In mammals, extracellular  $\text{Ca}^{2+}$  is under rigid homeostatic control and regulates various processes such as blood clotting, nerve and muscle excitability, and proper bone formation. Extracellular  $\text{Ca}^{2+}$  inhibits the secretion of parathyroid hormone ("PTH") from parathyroid cells, inhibits bone resorption by osteoclasts, and stimulates secretion of calcitonin from C-cells. Calcium receptor proteins enable certain specialized cells to  
10 respond to changes in extracellular  $\text{Ca}^{2+}$  concentration.

PTH is the principal endocrine factor regulating  $\text{Ca}^{2+}$  homeostasis in the blood and extracellular fluids. PTH, by acting on bone and kidney cells, increases the level of  $\text{Ca}^{2+}$  in the blood. This increase in extracellular  $\text{Ca}^{2+}$  then acts as a negative feedback signal, depressing PTH secretion. The reciprocal relationship between extracellular  $\text{Ca}^{2+}$  and  
15 PTH secretion forms an important mechanism maintaining bodily  $\text{Ca}^{2+}$  homeostasis.

Extracellular  $\text{Ca}^{2+}$  acts directly on parathyroid cells to regulate PTH secretion. The existence of a parathyroid cell surface protein which detects changes in extracellular  $\text{Ca}^{2+}$  has been confirmed. See Brown *et al.*, *Nature* 366:574, 1993. In parathyroid cells, this protein, the calcium receptor, acts as a receptor for extracellular  $\text{Ca}^{2+}$ , detects changes  
20 in the ion concentration of extracellular  $\text{Ca}^{2+}$ , and initiates a functional cellular response, PTH secretion.

Extracellular  $\text{Ca}^{2+}$  influences various cell functions, reviewed in Nemeth *et al.*, *Cell Calcium* 11:319, 1990. For example, extracellular  $\text{Ca}^{2+}$  plays a role in parafollicular (C-cells) and parathyroid cells. See Nemeth, *Cell Calcium* 11:323, 1990. The role of  
25 extracellular  $\text{Ca}^{2+}$  on bone osteoclasts has also been studied. See Zaidi, *Bioscience Reports* 10:493, 1990.

Various compounds are known to mimic the effects of extra-cellular  $\text{Ca}^{2+}$  on a calcium receptor molecule. Calcilytics are compounds able to inhibit calcium receptor activity, thereby causing a decrease in one or more calcium receptor activities evoked by  
30 extracellular  $\text{Ca}^{2+}$ . Calcilytics are useful as lead molecules in the discovery, development, design, modification and/or construction of useful calcium modulators which are active at  $\text{Ca}^{2+}$  receptors. Such calcilytics are useful in the treatment of various disease states characterized by abnormal levels of one or more components, e.g., polypeptides such as

hormones, enzymes or growth factors, the expression and/or secretion of which is regulated or affected by activity at one or more  $\text{Ca}^{2+}$  receptors. Target diseases or disorders for calcilytic compounds include diseases involving abnormal bone and mineral homeostasis.

Abnormal calcium homeostasis is characterized by one or more of the following activities: an abnormal increase or decrease in serum calcium; an abnormal increase or decrease in urinary excretion of calcium; an abnormal increase or decrease in bone calcium levels (for example, as assessed by bone mineral density measurements); an abnormal absorption of dietary calcium; an abnormal increase or decrease in the production and/or release of messengers which affect serum calcium levels such as PTH and calcitonin; and an abnormal change in the response elicited by messengers which affect serum calcium levels.

Thus, calcium receptor antagonists offer a unique approach towards the pharmacotherapy of diseases associated with abnormal bone or mineral homeostasis, such as hypoparathyroidism, osteosarcoma, periodontal disease, fracture healing, osteoarthritis, rheumatoid arthritis, Paget's disease, humoral hypercalcemia associated with malignancy and fracture healing, and osteoporosis.

#### **SUMMARY OF THE INVENTION**

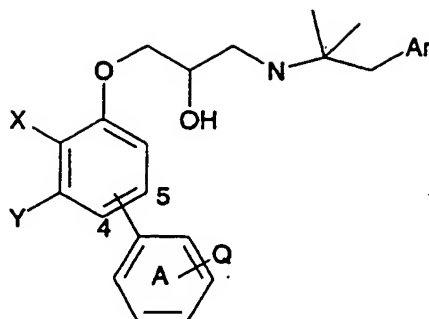
The present invention comprises novel calcium receptor antagonists represented by Formula (I) hereinbelow and their use as calcium receptor antagonists which are useful in the treatment of a variety of diseases associated with abnormal bone or mineral homeostasis, including but not limited to hypoparathyroidism, osteosarcoma, periodontal disease, fracture healing, osteoarthritis, rheumatoid arthritis, Paget's disease, humoral hypercalcemia associated with malignancy and fracture healing, and osteoporosis.

The present invention further provides a method for antagonizing calcium receptors in an animal, including humans, which comprises administering to an animal in need thereof an effective amount of a compound of Formula (I), indicated hereinbelow.

The present invention further provides a method for increasing serum parathyroid levels in an animal, including humans, which comprises administering to an animal in need thereof an effective amount of a compound of Formula (I), indicated hereinbelow.

#### **DETAILED DESCRIPTION OF THE INVENTION**

The compounds of the present invention are selected from Formula (I) hereinbelow:



I

wherein:

- 5 A represents an aryl ring that is attached at position 4 or 5, as indicated;  
 X is selected from the group consisting of CN, NO<sub>2</sub>, Cl, F, and H;  
 Y is selected from the group consisting of Cl, F, Br, I and H;  
 Q is selected from the group consisting of H, R<sub>1</sub>, SO<sub>2</sub>R<sub>1</sub>, R<sub>1</sub>C(O)OR'<sub>1</sub>, tetrazole, CH<sub>2</sub>OH,  
 COH, SO<sub>2</sub>NR<sub>1</sub>R'<sub>1</sub>, C(O)NR<sub>1</sub>R'<sub>1</sub>, and NR<sub>1</sub>SO<sub>2</sub>R'<sub>1</sub>, wherein R<sub>1</sub> and R'<sub>1</sub> are independently  
 10 selected from the group consisting of hydrogen, C<sub>1-4</sub> alkyl, and optionally substituted  
 alkyl,  
 or R<sub>1</sub> and R'<sub>1</sub> together form a 3 to 7 membered optionally substituted heterocyclic ring;  
 Ar is phenyl or naphthyl, unsubstituted or substituted, heteroaryl or fused heteroaryl, such  
 that the hetero-ring may contain N, O or S and may be aromatic, dihydro or tetrahydro,  
 15 unsubstituted or substituted.

- As used herein, "alkyl" refers to an optionally substituted hydrocarbon group joined  
 by single carbon-carbon bonds and having 1-20 carbon atoms joined together. The alkyl  
 hydrocarbon group may be linear, branched or cyclic, saturated or unsaturated. The  
 substituents are selected from F, Cl, Br, I, N, S and O. Preferably, no more than three  
 20 substituents are present. More preferably, the alkyl has 1-12 carbon atoms and is  
 unsubstituted. Preferably, the alkyl group is linear. Preferably, the alkyl group is saturated.  
 Preferably, substituents on optionally substituted alkyl are selected from the group  
 consisting of CN, aryl, CO<sub>2</sub>R, CO<sub>2</sub>NHR, OH, OR, CO, NH<sub>2</sub>, halo, CF<sub>3</sub>, OCF<sub>3</sub> and NO<sub>2</sub>,  
 wherein R represents H, C<sub>1-4</sub> alkyl, C<sub>3-6</sub> cycloalkyl, C<sub>2-5</sub> alkenyl, C<sub>2-5</sub> alkynyl,  
 25 heterocycloalkyl, aryl or aryl C<sub>1-4</sub> alkyl;

As used herein "lower alkyl" refers to C<sub>1-5</sub>

As used herein "cycloalkyl" refers to 3-7 membered carbocyclic rings

As used herein "heterocycloalkyl" refers to 4, 5, 6 or 7 membered heterocyclic rings containing 1 to 2 heteroatoms selected from N,O and S

As used herein, "aryl" refers to an optionally substituted aromatic group with at least one ring having a conjugated pi- electron system, containing up to two conjugated or fused ring systems. Aryl includes carbocyclic aryl, heterocyclic aryl and biaryl groups, all of which may be optionally substituted. Aryl substituents are preferably selected from the group consisting of OH, halo, CO<sub>2</sub>R<sub>1</sub>, C<sub>1-4</sub> alkyl, C<sub>1-4</sub> alkoxy, C<sub>3-6</sub> cycloalkyl, OSO<sub>2</sub>R<sub>1</sub>, CN, NO<sub>2</sub>, OCF<sub>3</sub>, CF<sub>3</sub>, CH<sub>2</sub>CF<sub>3</sub>, (CH<sub>2</sub>)<sub>n</sub> CO<sub>2</sub>H, (CH<sub>2</sub>)<sub>n</sub> CO<sub>2</sub>R<sub>1</sub>, O-(CH<sub>2</sub>)<sub>n</sub> and CO<sub>2</sub>R<sub>1</sub>, wherein n is an integer from 0 to 3 and R<sub>1</sub> represents C<sub>1-4</sub> alkyl, C<sub>3-6</sub> cycloalkyl or C<sub>3-6</sub> cycloalkyl. Preferred heteroaryl substituents are selected from the group consisting of OH, OCH<sub>3</sub>, CH(CH<sub>3</sub>)<sub>2</sub>, halo, CO<sub>2</sub>R<sub>1</sub>, C<sub>1-4</sub> alkyl, C<sub>1-4</sub> alkoxy, C<sub>3-6</sub> cycloalkyl, CN, NO<sub>2</sub>, OCF<sub>3</sub>, CF<sub>3</sub>, CH<sub>2</sub>CF<sub>3</sub>, (CH<sub>2</sub>)<sub>n</sub> CO<sub>2</sub>R<sub>1</sub>, and O-(CH<sub>2</sub>)<sub>n</sub> CO<sub>2</sub>R<sub>1</sub>.

The compounds of the present invention may contain one or more asymmetric carbon atoms and may exist in racemic and optically active forms. All of these compounds and diastereomers are contemplated to be within the scope of the present invention.

Preferred compounds of the present invention are selected from the group consisting of :

- N-[2R-Hydroxy-3-[2-cyano-5-[2-carbetoxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[2-cyano-5-[4-carbetoxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-5-[[4-carboxy]phenyl]phenoxy]propyl]-1,1-dimethyl-2-[naphthyl]ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-5-[2-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[4-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[carbetoxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[2-formylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[3-formylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[hydroxymethyl]phenyl]phenoxy]propyl]-

- 1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[[2-hydroxymethyl]phenyl]phenoxy]propyl]-  
 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[[ethyl]carboxyl]]phenyl]phenoxy]propyl]-  
 5 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[2-cyano-4-[3-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride; and  
 N-[2R-Hydroxy-3-[2-cyano-4-(2-carboxyphenyl)phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride.
- 10 N-[2R-Hydroxy-3-[[2-cyano-5-[4-carboxyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(4-fluorophenyl)ethylamine hydrochloride  
 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(5,6,7,8-tetrahydro-naphthalen-2-yl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-3-[2-(decahydro-naphthalen-2-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 15 3'-{(R)-3-(2-Benzo[b]thiophen-2-yl-1,1-dimethyl-ethylamino)-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[4-(2-methoxy-phenyl)-1,1-dimethyl-butylamino]-propoxy}-biphenyl-4-carboxylic acid
- 20 4'-Cyano-3'-{(R)-2-hydroxy-3-[4-phenyl-1,1-dimethyl-butylamino]-propoxy}-biphenyl-4-carb  
 3'-{(R)-3-(2-Benzo[b]thiophen-3-yl-1,1-dimethyl-ethylamino)-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(4-sulfamoyl-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 25 4'-Cyano-3'-{(R)-2-hydroxy-3-[1-(4-trifluoromethoxy-benzyl)-cyclopropylamino]-propoxy}-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[1-(2-methyl-benzyl)-cyclopropylamino]-propoxy}-biphenyl-4-carboxylic acid
- 30 4'-Cyano-3'-{(R)-3-(1-cyclohexylmethyl-cyclopropylamino)-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[1-(4-hydroxy-benzyl)-cyclopropylamino]-propoxy}-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[1-(2-trifluoromethyl-benzyl)-cyclopropylamino]-propoxy}-  
 35 biphenyl-4-carboxylic acid

- 4'-Cyano-3'-{(R)-2-hydroxy-3-[1-(4-chloro-benzyl)-cyclopropylamino]-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[1-(3-trifluoromethyl-benzyl)-cyclopropylamino]-propoxy}-biphenyl-4-carboxylic acid
- 5 4'-Cyano-3'-{(R)-2-hydroxy-3-[1-(4-bromo-benzyl)-cyclopropylamino]-propoxy}-biphenyl-4-car
- N-[(2R)-Hydroxy-3-[[2-cyano-5-[[4-carboxyl]phenyl]phenoxy]propyl]]-1,1-dimethyl-2-(5-chlorothieryl)ethylamine hydrochloride
- =
- 10 (R)-[[1,1-Dimethyl-2-(5-chlorothieryl)ethylamino]-2-hydroxypropyloxy]-3-(4-cyanobiphenyl-4'-carboxylic acid) hydrochloride ...
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(3-methoxy-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-4-carboxylic acid
- 3'-{(R)-3-[2-(4-tert-Butyl-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-
- 15 cyano-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[2-(3,5-dimethyl-isoxazol-4-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[2-(4-ethoxy-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 20 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(4-pyridin-4-yl-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- (R)-[[1,1-Dimethyl-2-(4-methylthienyl)ethylamino]-2-hydroxypropyloxy]-3-(4-cyanobiphenyl-4'-carboxylic acid) hydrochloride ..
- (R)-[[1,1-Dimethyl-2-(thienyl)ethylamino]-2-hydroxypropyloxy]-3-(4-
- 25 cyanobiphenyl-4'-carboxylic acid) hydrochloride ..
- (R)-[[1,1-Dimethyl-2-(5-methylthienyl)ethylamino]-2-hydroxypropyloxy]-3-(4-cyanobiphenyl-4'-carboxylic acid) hydrochloride ...
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[4-(2-methyl-phenyl)-1,1-dimethyl-butylamino]-propoxy}-biphenyl-4-carboxylic acid
- 30 4'-Cyano-3'-{(R)-2-hydroxy-3-[4-(4-pyridyl)-1,1-dimethyl-butylamino]-propoxy}-biphenyl-4-carboxylic acid
- 3'-[(R)-3-(4-Benzo[1,3]dioxol-5-yl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(3-phenoxy-phenyl)-ethylamino]-2-hydroxy-propoxy}-
- 35 biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(4-methylsulfanyl-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid.



- 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(3,4-dichloro-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid.
- 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(4-amino-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid.
- 5 4'-Cyano-3'-{(R)-3-[4-(2-cyano-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[4-(2-chloro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carbox
- 4'-Cyano-3'-{(R)-3-[4-(3-methoxy-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carbox.
- 10 4'-Cyano-3'-{(R)-3-[4-(2-trifluoromethyl-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[4-(3-trifluoromethoxy-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 15 4'-Cyano-3'-{(R)-3-[4-(2-fluoro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 3'-{(R)-3-[2-(4-Bromo-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carbox
- 3'-{(R)-3-[2-(3-Bromo-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 20 3'-{(R)-3-[2-(2-Bromo-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 3'-[(R)-3-(2-Biphenyl-4-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid
- 25 3'-[(R)-3-(2-Biphenyl-3-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid.
- 3'-[(R)-3-(2-Biphenyl-2-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid
- 3'-[(R)-3-(2-Benzo[1,3]dioxol-5-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid
- 30 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(4-phenoxy-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- (R)-1-(4-(4-carboxyphenyl)-2-cyanophenoxy)-3-(2-(5,8-diazanaphthyl)-1,1-dimethylethylamino)propanol
- 35 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(4-ethyl-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carb

- 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-hydroxy-1,1-dimethyl-2-(6-methyl-pyridin-2-yl)-ethylamino]-propoxy}-biphenyl-4-carboxylic acid  
 3'-{(R)-3-(2-Benzoyloxy-1,1-dimethyl-ethylamino)-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 5 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(3,4-dimethyl-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-carboxylic acid  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-methoxy-3-methyl-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-carboxylic acid  
 4'-Cyano-3'-{(R)-3-(1,1-dimethyl-2-quinolin-2-yl-ethylamino)-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 10 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(3-trifluoromethyl-benzyloxy)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-trifluoromethoxy-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-4-carboxylic acid
- 15 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-isopropyl-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-3-(1,1-dimethyl-2-{4-[(1-phenyl-methanoyl)-amino]-phenyl}-ethylamino)-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 3'-{(R)-3-[4-(3-chloro-4-methyl-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 20 4'-cyano-biphenyl-4-carboxylic acid  
 3'-{(R)-3-[4-(3,4-Dichloro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid  
 3'-{(R)-3-[4-(4-Chloro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 25 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-hydroxy-1,1-dimethyl-2-(6-methyl-pyridin-2-yl)-ethylamino]-propoxy}-biphenyl-4-carboxylic acid  
 N-[2R-Hydroxy-3-[(2-cyano-5-(4-carboxyphenyl)phenoxy)propyl]-1,1-dimethyl-2-(indan-2-yl)ethylamine hydrochloride  
 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-3-fluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 30 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-2-fluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-3-[4-(4-fluoro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 35 N-[2R-Hydroxy-3-[2-cyano-5-(4-carboxyphenyl)phenoxy]propyl]-1,1-dimethyl-2-(indan-5-yl)ethylamine, hydrochloride  
 N-[(2R)-Hydroxy-3-[[2-cyano-5-[[4-carboxy]phenyl]phenoxy]propyl]]-1,1-

- dimethyl-2-(hydroxy)-2-(tetra-6-yl)ethylamine  
 N-[(2R)-Hydroxy-3-[[2-cyano-5-[4-carboxylphenyl]phenoxy]propyl]]-1,1-dimethyl-2-thien-3-ylethylamine  
 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-3,5-difluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 5 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-2,6-difluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-2,5-difluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 10 3-[(S)-3-[2-(5-Chloro-thiophen-2-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid trifluoroacetate salt  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-methoxy-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-4-carboxylic acid

- 15 More preferred compounds useful in the present invention are selected from the group consisting of:

- N-[2R-Hydroxy-3-[2-cyano-5-[2-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 20 N-[2R-Hydroxy-3-[2-cyano-5-[4-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-5-[[4-carboxy]phenyl]phenoxy]propyl]]-1,1-dimethyl-2-[naphthyl]ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[4-carboxyphenyl]phenoxy]propyl]]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 25 N-[2R-Hydroxy-3-[[2-cyano-4-[carboxyphenyl]phenoxy]propyl]]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[2-formylphenyl]phenoxy]propyl]]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;  
 30 N-[2R-Hydroxy-3-[[2-cyano-4-[3-formylphenyl]phenoxy]propyl]]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[hydroxymethyl]phenyl]phenoxy]propyl]]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[[2-hydroxymethylphenyl]phenoxy]propyl]]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 35 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;

- N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[[ethyl]carboxyl]]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[2-cyano-4-[3-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride; and
- 5 N-[2R-Hydroxy-3-[2-cyano-4-(2-carboxyphenyl)phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride.
- N-[2R-Hydroxy-3-[[2-cyano-5-[4-carboxyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(4-fluorophenyl)ethylamine
- 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(5,6,7,8-tetrahydro-naphthalen-2-yl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 10 4'-Cyano-3'-{(R)-3-[2-(decahydro-naphthalen-2-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 3'-{(R)-3-(2-Benzo[b]thiophen-2-yl)-1,1-dimethyl-ethylamino)-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid
- 15 4'-Cyano-3'-{(R)-2-hydroxy-3-[4-(2-methoxy-phenyl)-1,1-dimethyl-butylamino]-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[4-phenyl-1,1-dimethyl-butylamino]-propoxy}-biphenyl-4-carboxylic acid
- 3'-{(R)-3-(2-Benzo[b]thiophen-3-yl)-1,1-dimethyl-ethylamino)-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid
- 20 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(4-sulfamoyl-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[1-(4-trifluoromethoxy-benzyl)-cyclopropylamino]-propoxy}-biphenyl-4-carboxylic acid
- 25 N-[(2R)-Hydroxy-3-[[2-cyano-5-[[4-carboxyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(5-chlorothieryl)ethylamine
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(3-methoxy-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-4-carboxylic acid
- 3'-{(R)-3-[2-(4-tert-Butyl-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid
- 30 4'-Cyano-3'-{(R)-3-[2-(4-ethoxy-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- (R)-[[1,1-Dimethyl-2-(4-methylthienyl)ethylamino]-2-hydroxypropyloxy]-3-(4-cyanobiphenyl-4'-carboxylic acid)
- 35 (R)-[[1,1-Dimethyl-2-(thienyl)ethylamino]-2-hydroxypropyloxy]-3-(4-cyanobiphenyl-4'-carboxylic acid)

- (R)-[[1,1-Dimethyl-2-(5-methylthienyl)ethylamino]-2-hydroxypropyloxy]-3-(4-cyanobiphenyl-4'-carboxylic acid)
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[4-(2-methyl-phenyl)-1,1-dimethyl-butylamino]-propoxy}-biphenyl-4-carboxylic acid
- 5 4'-Cyano-3'-{(R)-2-hydroxy-3-[4-(4-pyridyl)-1,1-dimethyl-butylamino]-propoxy}-biphenyl-4-carboxylic acid
- 3'-{(R)-3-(4-Benzo[1,3]dioxol-5-yl)-1,1-dimethyl-butylamino)-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(4-methylsulfanyl-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid.
- 10 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(3,4-dichloro-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid.
- 4'-Cyano-3'-{(R)-3-[4-(2-cyano-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 15 4'-Cyano-3'-{(R)-3-[4-(2-chloro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carbox
- 4'-Cyano-3'-{(R)-3-[4-(3-methoxy-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carbox.
- 4'-Cyano-3'-{(R)-3-[4-(2-trifluoromethyl-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 20 4'-Cyano-3'-{(R)-3-[4-(3-trifluoromethoxy-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[4-(2-fluoro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 25 3'-{(R)-3-[2-(4-Bromo-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carbox
- 3'-{(R)-3-[2-(3-Bromo-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 3'-{(R)-3-[2-(2-Bromo-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 30 3'-{(R)-3-(2-Benzo[1,3]dioxol-5-yl)-1,1-dimethyl-ethylamino)-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(4-ethyl-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carb
- 35 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-hydroxy-1,1-dimethyl-2-(6-methyl-pyridin-2-yl)-ethylamino]-propoxy}-biphenyl-4-carboxylic acid

- 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(3,4-dimethyl-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-carboxylic acid
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-methoxy-3-methyl-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-carboxylic acid
- 5 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-trifluoromethoxy-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-isopropyl-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-4-carboxylic acid
- 3'-{(R)-3-[4-(3-chloro-4-methyl-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-
- 10 4'-cyano-biphenyl-4-carboxylic acid
- 3'-{(R)-3-[4-(3,4-Dichloro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 3'-{(R)-3-[4-(4-Chloro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 15 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-hydroxy-1,1-dimethyl-2-(6-methyl-pyridin-2-yl)-ethylamino]-propoxy}-biphenyl-4-carboxylic acid
- N-[2R-Hydroxy-3-[[2-cyano-5-(4-carboxyphenyl)phenoxy]propyl]-1,1-dimethyl-2-(indan-2-yl)ethylamine hydrochloride
- 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-3-fluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 20 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-2-fluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[4-(4-fluoro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 25 N-[2R-Hydroxy-3-[2-cyano-5-(4-carboxyphenyl)phenoxy]propyl]-1,1-dimethyl-2-(indan-5-yl)ethylamine, hydrochloride
- N-[(2R)-Hydroxy-3-[[2-cyano-5-[[4-carboxy]phenyl]phenoxy]propyl]]-1,1-dimethyl-2-(hydroxy)-2-(tetral-6-yl)ethylamine
- N-[(2R)-Hydroxy-3-[[2-cyano-5-[4-carboxylphenyl]phenoxy]propyl]]-1,1-dimethyl-2-
- 30 thien-3-ylethylamine
- 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-3,5-difluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-2,6-difluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 35 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-2,5-difluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 3-{(S)-3-[2-(5-Chloro-thiophen-2-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-

propoxy)-4'-cyano-biphenyl-4-carboxylic acid trifluoroacetate salt  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-methoxy-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-  
 biphenyl-4-carboxylic acid

The most preferred compounds useful in the present invention are selected from the

5 group consisting of:

- N-[2R-Hydroxy-3-[[2-cyano-5-[4-carboxyl]phenyl]phenoxy]propyl]-1,1-  
 dimethyl-2-(4-fluorophenyl)ethylamine hydrochloride  
 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(5,6,7,8-tetrahydro-naphthalen-2-yl)-ethylamino]-2-  
 hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 10 4'-Cyano-3'-{(R)-3-[2-(decahydro-naphthalen-2-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-  
 propoxy}-biphenyl-4-carboxylic acid  
 3'-[(R)-3-(2-Benzo[b]thiophen-2-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy]-4'-  
 cyano-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[4-(2-methoxy-phenyl)-1,1-dimethyl-butylamino]-  
 15 propoxy}-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[4-phenyl-1,1-dimethyl-butylamino]-propoxy}-biphenyl-4-  
 carb  
 3'-[(R)-3-(2-Benzo[b]thiophen-3-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy]-4'-  
 cyano-biphenyl-4-carboxylic acid  
 20 N-[(2R)-Hydroxy-3-[[2-cyano-5-[[4-carboxyl]phenyl]phenoxy]propyl]]-1,1-  
 dimethyl-2-(5-chlorothiényl)ethylamine hydrochloride  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(3-methoxy-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-  
 biphenyl-4-carboxylic acid  
 3'-{(R)-3-[2-(4-tert-Butyl-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-  
 25 cyano-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-3-[2-(4-ethoxy-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-  
 biphenyl-4-carboxylic acid  
 (R)-[[1,1-Dimethyl-2-(4-methylthienyl)ethylamino]-2-hydroxypropyloxy]-3-(4-  
 cyanobiphenyl-4'-carboxylic acid) hydrochloride ..  
 30 (R)-[[1,1-Dimethyl-2-(thienyl)ethylamino]-2-hydroxypropyloxy]-3-(4-  
 cyanobiphenyl-4'-carboxylic acid) hydrochloride ..  
 (R)-[[1,1-Dimethyl-2-(5-methylthienyl)ethylamino]-2-hydroxypropyloxy]-3-(4-  
 cyanobiphenyl-4'-carboxylic acid) hydrochloride ...  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[4-(2-methyl-phenyl)-1,1-dimethyl-butylamino]-propoxy}-  
 35 biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(4-methylsulfanyl-phenyl)-ethylamino]-2-hydroxy-  
 propoxy}-biphenyl-4-carboxylic acid.

- 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(3,4-dichloro-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid.
- 4'-Cyano-3'-{(R)-3-[4-(2-chloro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carbox
- 5 4'-Cyano-3'-{(R)-3-[4-(3-methoxy-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carbox.
- 4'-Cyano-3'-{(R)-3-[4-(2-trifluoromethyl-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-3-[4-(3-trifluoromethoxy-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 10 4'-Cyano-3'-{(R)-3-[4-(2-fluoro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid
- 3'-{(R)-3-[2-(4-Bromo-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carbox
- 15 3'-{(R)-3-[2-(3-Bromo-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 3'-{(R)-3-[2-(2-Bromo-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 3'-{(R)-3-[2-(Benzo[1,3]dioxol-5-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 20 4'-Cyano-3'-{(R)-3-[1,1-dimethyl-2-(4-ethyl-phenyl)-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carb
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(3,4-dimethyl-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-carboxylic acid
- 25 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-methoxy-3-methyl-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-carboxylic acid
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-trifluoromethoxy-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-4-carboxylic acid
- 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-isopropyl-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-4-carboxylic acid
- 30 3'-{(R)-3-[4-(3-chloro-4-methyl-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 3'-{(R)-3-[4-(3,4-Dichloro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- 35 3'-{(R)-3-[4-(4-Chloro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-4'-cyano-biphenyl-4-carboxylic acid
- N-[2R-Hydroxy-3-[(2-cyano-5-(4-carboxyphenyl)phenoxy)propyl]-1,1-dimethyl-2-



- (indan-2-yl)ethylamine hydrochloride  
 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-3-fluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-2-fluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 5 4'-Cyano-3'-{(R)-3-[4-(4-fluoro-phenyl)-1,1-dimethyl-butylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 N-[2R-Hydroxy-3-[2-cyano-5-(4-carboxyphenyl)phenoxy]propyl]-1,1-dimethyl-2-(indan-5-yl)ethylamine, hydrochloride  
 10 N-[(2R)-Hydroxy-3-[[2-cyano-5-[[4-carboxy]phenyl]phenoxy]propyl]]-1,1-dimethyl-2-(hydroxy)-2-(tetra-6-yl)ethylamine  
 N-[(2R)-Hydroxy-3-[[2-cyano-5-[4-carboxylphenyl]phenoxy]propyl]]-1,1-dimethyl-2-thien-3-ylethylamine  
 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-3,5-difluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 15 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-2,6-difluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 4'-Cyano-3'-{(R)-3-[2-(4-ethyl-2,5-difluoro-phenyl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy}-biphenyl-4-carboxylic acid  
 20 3-[(S)-3-[2-(5-Chloro-thiophen-2-yl)-1,1-dimethyl-ethylamino]-2-hydroxy-propoxy]-4'-cyano-biphenyl-4-carboxylic acid trifluoroacetate salt  
 4'-Cyano-3'-{(R)-2-hydroxy-3-[2-(4-methoxy-phenyl)-1,1-dimethyl-ethylamino]-propoxy}-biphenyl-4-carboxylic acid  
 N-[2R-Hydroxy-3-[2-cyano-5-[2-carboxyphenyl]phenoxy]propyl]-  
 25 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[2-cyano-5-[4-carboxyphenyl]phenoxy]propyl]-  
 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-5-[[4-carboxy]phenyl]phenoxy]propyl]]-  
 1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;  
 30 N-[2R-Hydroxy-3-[[2-cyano-4-[4-carboxyphenyl]phenoxy]propyl]]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[carboxyphenyl]phenoxy]propyl]]-  
 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[2-formylphenyl]phenoxy]propyl]]-1,1-  
 35 dimethyl-2-(naphthyl)ethylamine hydrochloride;

- N-[2R-Hydroxy-3-[[2-cyano-4-[3-formylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[hydroxymethyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;
- 5 N-[2R-Hydroxy-3-[[2-cyano-4-[[2-hydroxymethyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[[ethyl]carboxyl]]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[2-cyano-4-[3-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-
- 10 naphthyl)ethylamine hydrochloride; and
- N-[2R-Hydroxy-3-[2-cyano-4-(2-carboxyphenyl)phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine

Pharmaceutically acceptable salts are non-toxic salts in the amounts and

15 concentrations at which they are administered.

Pharmaceutically acceptable salts include acid addition salts such as those containing sulfate, hydrochloride, fumarate, maleate, phosphate, sulfamate, acetate, citrate, lactate, tartrate, methanesulfonate, ethanesulfonate, benzenesulfonate, *p*-toluenesulfonate, cyclohexylsulfamate and quinate. A preferred salt is a hydrochloride. Pharmaceutically

20 acceptable salts can be obtained from acids such as hydrochloric acid, maleic acid, sulfuric acid, phosphoric acid, sulfamic acid, acetic acid, citric acid, lactic acid, tartaric acid, malonic acid, methanesulfonic acid, ethanesulfonic acid, benzenesulfonic acid, *p*-toluenesulfonic acid, cyclohexylsulfamic acid, fumaric acid, and quinic acid.

Pharmaceutically acceptable salts also include basic addition salts such as those

25 containing benzathine, chlorprocaine, choline, diethanolamine, ethylenediamine, meglumine, procaine, aluminum, calcium, lithium, magnesium, potassium, sodium, ammonium, alkylamine, and zinc, when acidic functional groups, such as carboxylic acid or phenol are present.

The present invention provides compounds of Formula (I) above which can be

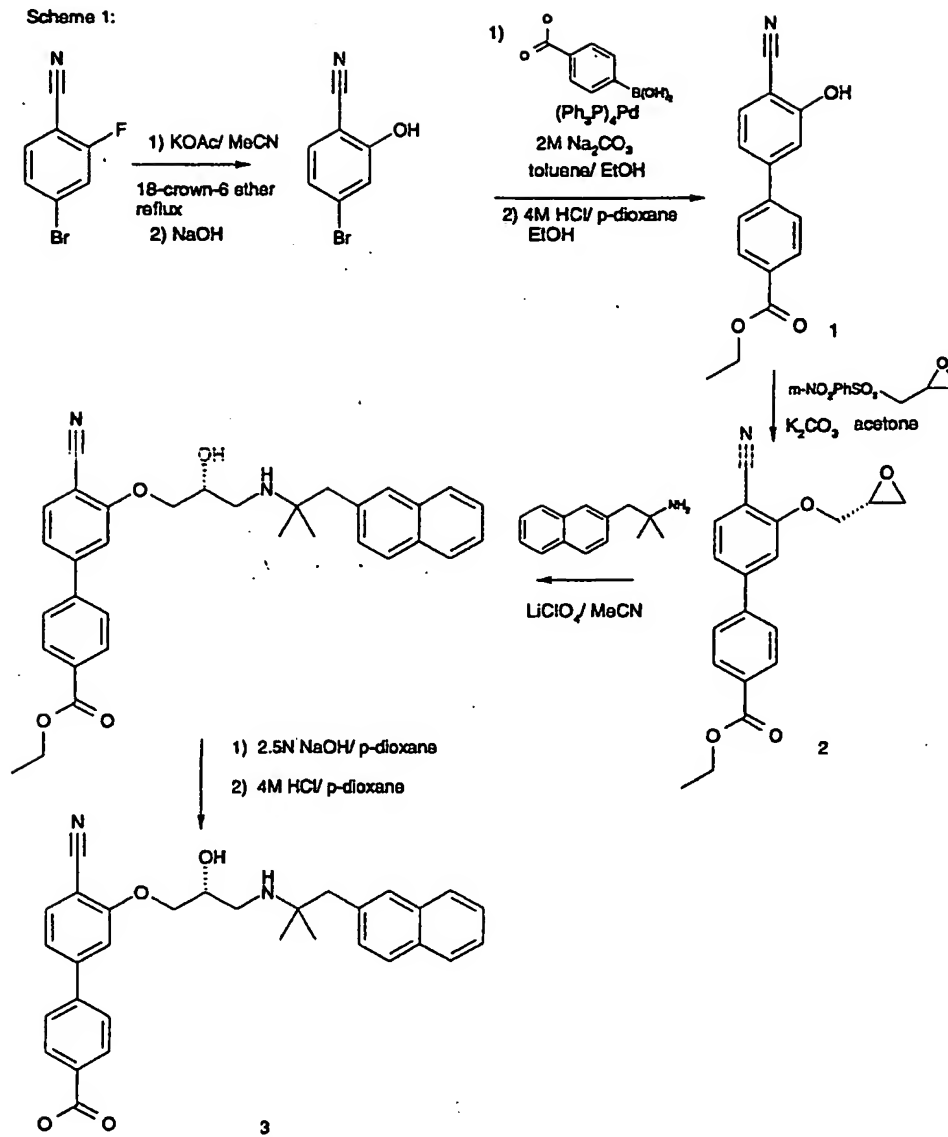
30 prepared using standard techniques. An overall strategy for preparing preferred compounds described herein can be carried out as described in this section. The examples which follow illustrate the synthesis of specific compounds. Using the protocols described herein as a model, one of ordinary skill in the art can readily produce other compounds of the present invention.

All reagents and solvents were obtained from commercial vendors. Starting materials (e.g., amines and epoxides) were synthesized using standard techniques and procedures.

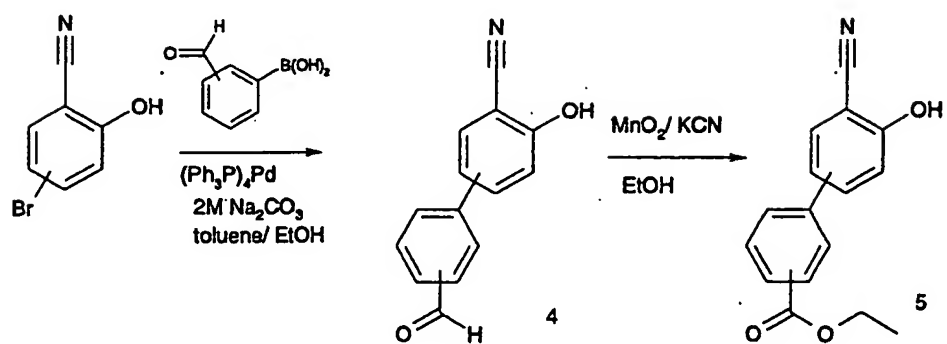
Compound the formula I are prepared by the general methods described in Scheme 1, 2 and 3. A general procedure used to synthesize many of the compounds was carried out as follows. For example, treatment of 2-Fluoro-4-bromobenzonitrile with potassium acetate in refluxing acetonitrile produces the corresponding phenol after saponification of the resulting acetate (see Scheme 1). Suzuki coupling of the bromohalide with an appropriately substituted boronic acid such as in Scheme I, leads to the formation of the corresponding biphenylcarboxi derivative that can be converted to the corresponding ester under standard conditions. Alternatively, the Suzuki coupling can be carried out with an appropriately substituted formyl boronic acid as described in Scheme 2, the formyl biphenyl analog 4 could then be oxidized under standard conditions and transformed to the corresponding ethyl ester 5. A solution an aryl alcohol such 1-Scheme 1 or 5-Scheme 2 in acetone is treated with  $K_2CO_3$  heated for 15 min. R-glycidyl nosylate is added and the reaction continued overnight to give the corresponding aryloxy epoxide such as 2-Scheme 1.

A solution of a glycidyl ether such as 2-Scheme 1, and excess amine (typically 1,1-dimethyl-2-(2-naphthyl)ethylamine) in absolute ethanol (2 mL), acetonitrile, THF or any other similar solvent in the presence of a suitable catalyst such as  $LiClO_4$  (1-2 mmol) is stirred overnight at reflux. The product, such as 3-Scheme 1, is purified by normal phase chromatography. Hydrochloride salts were prepared by treatment of the corresponding free base with HCl either in gas phase or 4M dioxane solution, or any other standard method.

Scheme 1:

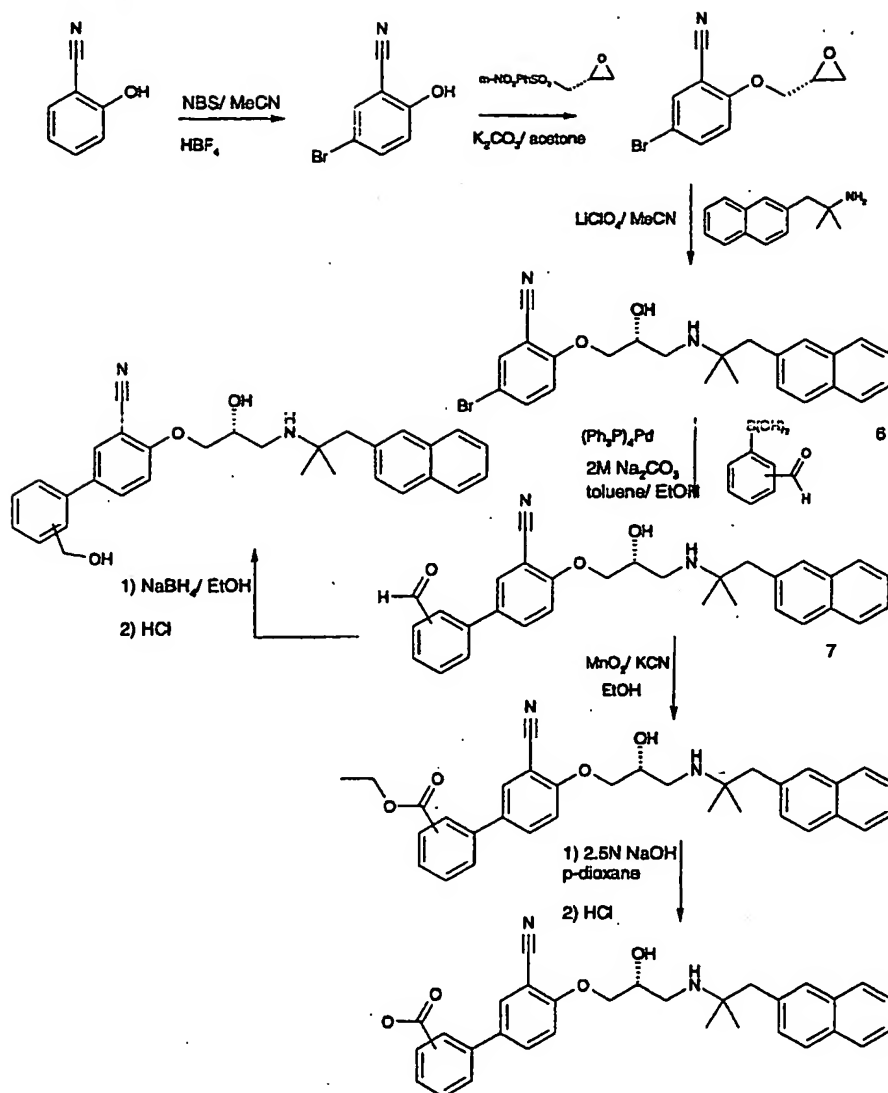


Scheme 2:



Alternatively, the claimed compounds can also be synthesized by the route described in Scheme 3. The selective bromination at the para position of 2-cyanophenol, can be accomplish for example via the reaction of N-bromosuccinimide in the presence of an acid such as Fluoroboric acid, or any other suitable protic acid, in a solvent such as acetonitrile or any other suitable solvent, following a procedure described in the literature (Oberhauser, T. *J. Org. Chem.*, 1997, 62, 4504-4506). Formation of the corresponding aminoalcohol 6 can then be accomplished by following the reaction sequence described in Scheme 1. Suzuki coupling of 6-Scheme 3 with and appropriately substituted formyl boronic acid or carboxy boronic acid would lead to the corresponding formyl biphenyl compound 7-Scheme 3. In turn, 7-Scheme e can be converted to the corresponding carboxy derivatives as described in Scheme 2 or to the corresponding alcohol via reduction with sodium borohydride as described in Scheme 3.

**Scheme 3:**



Nuclear magnetic resonance spectra were recorded at either 250 or 400 MHz using, respectively, a Bruker AM 250 or Bruker AC 400 spectrometer.  $\text{CDCl}_3$  is

5 deuteriochloroform, DMSO-d<sub>6</sub> is hexadeuteriodimethylsulfoxide, and CD<sub>3</sub>OD is  
tetrauteriomethanol. Chemical shifts are reported in parts per million (ppm) downfield from  
the internal standard tetramethylsilane. Abbreviations for <sup>1</sup>H-NMR data are as follows:  
s=singlet, d=doublet, t=triplet, q=quartet, m=multiplet, dd=doublet of doublets, dt=doublet  
of triplets, app=apparent, br=broad. J indicates the <sup>1</sup>H-NMR coupling constant measured  
10 in Hertz. Continuous wave infrared (IR) spectra were recorded on a Perkin-Elmer 683  
infrared spectrometer, and Fourier transform infrared (FTIR) spectra were recorded on a

Nicolet Impact 400 D infrared spectrometer. IR and FTIR spectra were recorded in transmission mode, and band positions are reported in inverse wavenumbers ( $\text{cm}^{-1}$ ). Mass spectra were taken on either VG 70 FE, PE Syx API III, or VG ZAB HF instruments, using fast atom bombardment (FAB) or electrospray (ES) ionization techniques. Elemental analyses were obtained using a Perkin-Elmer 240C elemental analyzer. Melting points were taken on a Thomas-Hoover melting point apparatus and are uncorrected. All temperatures are reported in degrees Celsius.

Analtech Silica Gel GF and E. Merck Silica Gel 60 F-254 thin layer plates were used for thin layer chromatography. Both flash and gravity chromatography were carried out on E. Merck Kieselgel 60 (230-400 mesh) silica gel. Analytical and preparative HPLC were carried out on Rainin or Beckman chromatographs. ODS refers to an octadecylsilyl derivatized silica gel chromatographic support. 5  $\mu$  Apex-ODS indicates an octadecylsilyl derivatized silica gel chromatographic support having a nominal particle size of 5  $\mu$ , made by Jones Chromatography, Littleton, Colorado. YMC ODS-AQ® is an ODS chromatographic support and is a registered trademark of YMC Co. Ltd., Kyoto, Japan. PRP-1® is a polymeric (styrene-divinylbenzene) chromatographic support, and is a registered trademark of Hamilton Co., Reno, Nevada) Celite® is a filter aid composed of acid-washed diatomaceous silica, and is a registered trademark of Manville Corp., Denver, Colorado.

With appropriate manipulation and protection of any chemical functionality, synthesis of the remaining compounds of Formula (I) is accomplished by methods analogous to those above and to those described in the Experimental section.

In order to use a compound of Formula (I) or a pharmaceutically acceptable salt thereof for the treatment of humans and other mammals, it is normally formulated in accordance with standard pharmaceutical practice as a pharmaceutical composition.

The calcilytic compounds can be administered by different routes including intravenous, intraperitoneal, subcutaneous, intramuscular, oral, topical (transdermal), or transmucosal administration. For systemic administration, oral administration is preferred. For oral administration, for example, the compounds can be formulated into conventional oral dosage forms such as capsules, tablets, and liquid preparations such as syrups, elixirs, and concentrated drops.

Alternatively, injection (parenteral administration) may be used, *e.g.*, intramuscular, intravenous, intraperitoneal, and subcutaneous. For injection, the compounds of the invention are formulated in liquid solutions, preferably, in

physiologically compatible buffers or solutions, such as saline solution, Hank's solution, or Ringer's solution. In addition, the compounds may be formulated in solid form and redissolved or suspended immediately prior to use. Lyophilized forms can also be produced.

5           Systemic administration can also be by transmucosal or transdermal means. For transmucosal or transdermal administration, penetrants appropriate to the barrier to be permeated are used in the formulation. Such penetrants are generally known in the art, and include, for example, for transmucosal administration, bile salts and fusidic acid derivatives. In addition, detergents may be used to facilitate permeation. Transmucosal  
10 administration, for example, may be through nasal sprays, rectal suppositories, or vaginal suppositories.

For topical administration, the compounds of the invention can be formulated into ointments, salves, gels, or creams, as is generally known in the art.

15           The amounts of various calcilytic compounds to be administered can be determined by standard procedures taking into account factors such as the compound  $IC_{50}$ ,  $EC_{50}$ , the biological half-life of the compound, the age, size and weight of the patient, and the disease or disorder associated with the patient. The importance of these and other factors to be considered are known to those of ordinary skill in the art.

20           Amounts administered also depend on the routes of administration and the degree of oral bioavailability. For example, for compounds with low oral bioavailability, relatively higher doses will have to be administered.

25           Preferably the composition is in unit dosage form. For oral application, for example, a tablet, or capsule may be administered, for nasal application, a metered aerosol dose may be administered, for transdermal application, a topical formulation or patch may be administered and for transmucosal delivery, a buccal patch may be administered. In each case, dosing is such that the patient may administer a single dose.

30           Each dosage unit for oral administration contains suitably from 0.01 to 500 mg/Kg, and preferably from 0.1 to 50 mg/Kg, of a compound of Formula (I) or a pharmaceutically acceptable salt thereof, calculated as the free base. The daily dosage for parenteral, nasal, oral inhalation, transmucosal or transdermal routes contains suitably from 0.01 mg to 100 mg/Kg, of a compound of Formula(I). A topical formulation contains suitably 0.01 to 5.0% of a compound of Formula (I). The active ingredient may be administered from 1 to 6 times per day, preferably once, sufficient to exhibit the desired activity, as is readily apparent to one skilled in the art.



As used herein, "treatment" of a disease includes, but is not limited to prevention, retardation and prophylaxis of the disease.

Diseases and disorders which might be treated or prevented, based upon the affected cells, include bone and mineral-related diseases or disorders; hypoparathyroidism; 5 those of the central nervous system such as seizures, stroke, head trauma, spinal cord injury, hypoxia-induced nerve cell damage, such as occurs in cardiac arrest or neonatal distress, epilepsy, neurodegenerative diseases such as Alzheimer's disease, Huntington's disease and Parkinson's disease, dementia, muscle tension, depression, anxiety, panic disorder, obsessive-compulsive disorder, post-traumatic stress disorder, schizophrenia, 10 neuroleptic malignant syndrome, and Tourette's syndrome; diseases involving excess water reabsorption by the kidney, such as syndrome of inappropriate ADH secretion (SIADH), cirrhosis, congestive heart failure, and nephrosis; hypertension; preventing and/or decreasing renal toxicity from cationic antibiotics (*e.g.*, aminoglycoside antibiotics); gut motility disorders such as diarrhea and spastic colon; GI ulcer diseases; GI diseases with 15 excessive calcium absorption such as sarcoidosis; autoimmune diseases and organ transplant rejection; squamous cell carcinoma; and pancreatitis.

In a preferred embodiment of the present invention, the present compounds are used to increase serum parathyroid hormone ("PTH") levels. Increasing serum PTH levels can be helpful in treating diseases such as hypoparathyroidism, osteosarcoma, periodontal 20 disease, fracture, osteoarthritis, rheumatoid arthritis, Paget's disease, humoral hypercalcemia malignancy and osteoporosis.

Another aspect of the present invention describes a method of treating a patient comprising administering to the patient an amount of a present compound sufficient to increase the serum PTH level. Preferably, the method is carried out by administering an 25 amount of the compound effective to cause an increase in duration and/or quantity of serum PTH level sufficient to have a therapeutic effect.

In various embodiments, the compound administered to a patient causes an increase in serum PTH having a duration of up to one hour, about one to about twenty-four hours, about one to about twelve hours, about one to about six hours, about one to about 30 five hours, about one to about four hours, about two to about five hours, about two to about four hours, or about three to about six hours.

In additional different embodiments, the compound administered to a patient causes an increase in serum PTH of up to two fold, two to five fold, five to ten fold, and at

least 10 fold, greater than peak serum PTH in the patient. The peak serum level is measured with respect to a patient not undergoing treatment.

Composition of Formula (I) and their pharmaceutically acceptable salts which are active when given orally can be formulated as syrups, tablets, capsules and lozenges. A  
5 syrup formulation will generally consist of a suspension or solution of the compound or salt in a liquid carrier for example, ethanol, peanut oil, olive oil, glycerine or water with a flavoring or coloring agent. Where the composition is in the form of a tablet, any pharmaceutical carrier routinely used for preparing solid formulations may be used. Examples of such carriers include magnesium stearate, terra alba, talc, gelatin, acacia,  
10 stearic acid, starch, lactose and sucrose. Where the composition is in the form of a capsule, any routine encapsulation is suitable, for example using the aforementioned carriers in a hard gelatin capsule shell. Where the composition is in the form of a soft gelatin shell capsule any pharmaceutical carrier routinely used for preparing dispersions or suspensions may be considered, for example aqueous gums, celluloses, silicates or oils, and are  
15 incorporated in a soft gelatin capsule shell.

Typical parenteral compositions consist of a solution or suspension of a compound or salt in a sterile aqueous or non-aqueous carrier optionally containing a parenterally acceptable oil, for example polyethylene glycol, polyvinylpyrrolidone, lecithin, arachis oil or sesame oil.

20 Typical compositions for inhalation are in the form of a solution, suspension or emulsion that may be administered as a dry powder or in the form of an aerosol using a conventional propellant such as dichlorodifluoromethane or trichlorofluoromethane.

A typical suppository formulation comprises a compound of Formula (I) or a pharmaceutically acceptable salt thereof which is active when administered in this way,  
25 with a binding and/or lubricating agent, for example polymeric glycols, gelatins, cocoa-butter or other low melting vegetable waxes or fats or their synthetic analogs.

Typical dermal and transdermal formulations comprise a conventional aqueous or non-aqueous vehicle, for example a cream, ointment, lotion or paste or are in the form of a medicated plaster, patch or membrane.

30 Preferably the composition is in unit dosage form, for example a tablet, capsule or metered aerosol dose, so that the patient may administer a single dose.

No unacceptable toxological effects are expected when compounds of the present invention are administered in accordance with the present invention.

The biological activity of the compounds of Formula (I) are demonstrated by the following tests:

**(I) Calcium Receptor Inhibitor Assay**

Calcilytic activity was measured by determining the  $IC_{50}$  of the test compound for blocking increases of intracellular  $Ca^{2+}$  elicited by extracellular  $Ca^{2+}$  in HEK 293 4.0-7 cells stably expressing the human calcium receptor. HEK 293 4.0-7 cells were constructed as described by Rogers *et al.*, *J. Bone Miner. Res.* 10 Suppl. 1:S483, 1995 (hereby incorporated by reference herein). Intracellular  $Ca^{2+}$  increases were elicited by increasing extracellular  $Ca^{2+}$  from 1 to 1.75 mM. Intracellular  $Ca^{2+}$  was measured using fluo-3, a fluorescent calcium indicator.

The procedure was as follows:

1. Cells were maintained in T-150 flasks in selection media (DMEM supplemented with 10% fetal bovine serum and 200 ug/mL hygromycin B), under 5%  $CO_2$ :95% air at 37 °C and were grown up to 90% confluency.
2. The medium was decanted and the cell monolayer was washed twice with phosphate-buffered saline (PBS) kept at 37 °C. After the second wash, 6 mL of 0.02% EDTA in PBS was added and incubated for 4 minutes at 37 °C. Following the incubation, cells were dispersed by gentle agitation.
3. Cells from 2 or 3 flasks were pooled and pelleted (100 x g). The cellular pellet was resuspended in 10-15 mL of SPF-PCB+ and pelleted again by centrifugation. This washing was done twice.

Sulfate- and phosphate-free parathyroid cell buffer (SPF-PCB) contains 20 mM Na-Hepes, pH 7.4, 126 mM NaCl, 5 mM KCl, and 1 mM  $MgCl_2$ . SPF-PCB was made up and stored at 4 °C. On the day of use, SPF-PCB was supplemented with 1 mg/mL of D-glucose and 1 mM  $CaCl_2$  and then split into two fractions. To one fraction, bovine serum albumin (BSA; fraction V, ICN) was added at 5 mg/mL (SPF-PCB+). This buffer was used for washing, loading and maintaining the cells. The BSA-free fraction was used for diluting the cells in the cuvette for measurements of fluorescence.

4. The pellet was resuspended in 10 mL of SPF-PCB+ containing 2.2 uM fluo-3 (Molecular Probes) and incubated at room temperature for 35 minutes.
5. Following the incubation period, the cells were pelleted by centrifugation. The resulting pellet was washed with SPF-PCB+. After this washing, cells were resuspended in SPF-PCB+ at a density of  $1-2 \times 10^6$  cells/mL.

6. For recording fluorescent signals, 300  $\mu$ L of cell suspension were diluted in 1.2 mL of SPF buffer containing 1 mM  $\text{CaCl}_2$  and 1 mg/mL of D-glucose. Measurements of fluorescence were performed at 37  $^\circ\text{C}$  with constant stirring using a spectrofluorimeter. Excitation and emission wavelengths were measured at 485 and 535 nm, respectively. To  
5 calibrate fluorescence signals, digitonin (5 mg/mL in ethanol) was added to obtain  $F_{\text{max}}$ , and the apparent  $F_{\text{min}}$  was determined by adding Tris-EGTA (2.5 M Tris-Base, 0.3 M EGTA). The concentration of intracellular calcium was calculated using the following equation:

$$\text{Intracellular calcium} = (F - F_{\text{min}} / F_{\text{max}}) \times K_d; \text{ where } K_d = 400 \text{ nM.}$$

10 7. To determine the potential calcilytic activity of test compounds, cells were incubated with test compound (or vehicle as a control) for 90 seconds before increasing the concentration of extracellular  $\text{Ca}^{2+}$  from 1 to 2mM. Calcilytic compounds were detected by their ability to block, in a concentration-dependent manner, increases in the concentration of intracellular  $\text{Ca}^{2+}$  elicited by extracellular  $\text{Ca}^{2+}$ .

15 In general, those compounds having lower  $\text{IC}_{50}$  values in the Calcium Receptor Inhibitor Assay are more preferred compounds. Compounds having an  $\text{IC}_{50}$  greater than 50  $\mu\text{M}$  were considered to be inactive. Preferred compounds are those having an  $\text{IC}_{50}$  of 10 $\mu\text{M}$  or lower, more preferred compounds have an  $\text{IC}_{50}$  of 1 $\mu\text{M}$ , and most preferred compounds have an  $\text{IC}_{50}$  of 0.1 $\mu\text{M}$  or lower.

20 (II) Calcium Receptor Binding Assay

HEK 293 4.0-7 cells stably transfected with the Human Parathyroid Calcium Receptor ("HuPCaR") were scaled up in T180 tissue culture flasks. Plasma membrane is obtained by polytron homogenization or glass douncing in buffer (50mM Tris-HCl pH 7.4, 1mM EDTA, 3mM  $\text{MgCl}_2$ ) in the presence of a protease inhibitor cocktail containing 1 $\mu\text{M}$   
25 Leupeptin, 0.04  $\mu\text{M}$  Pepstatin, and 1 mM PMSF. Aliquoted membrane was snap frozen and stored at -80 $^\circ\text{C}$ .  $^3\text{H}$  labeled compound was radiolabeled to a radiospecific activity of 44Ci/mmmole and was aliquoted and stored in liquid nitrogen for radiochemical stability.

A typical reaction mixture contains 2 nM  $^3\text{H}$  compound ((R,R)-N-4'-Methoxy-t-3-3'-methyl-1'-ethylphenyl-1-(1-naphthyl)ethylamine), or  $^3\text{H}$  compound (R)-N-[2-Hydroxy-3-(3-chloro-2-cyanophenoxy)propyl]-1,1-dimethyl-2-(4-methoxyphenyl)ethylamine  
30 ug membrane in homogenization buffer containing 0.1% gelatin and 10% EtOH in a reaction volume of 0.5 mL. Incubation is performed in 12 x 75 polyethylene tubes in an ice water bath. To each tube 25  $\mu\text{L}$  of test sample in 100% EtOH is added, followed by 400  $\mu\text{L}$  of cold incubation buffer, and 25  $\mu\text{L}$  of 40 nM  $^3\text{H}$ -compound in 100% EtOH for a final

concentration of 2nM. The binding reaction is initiated by the addition of 50 uL of 80-200 ug/mL HEK 293 4.0-7 membrane diluted in incubation buffer, and allowed to incubate at 4°C for 30 min. Wash buffer is 50 mM Tris-HCl containing 0.1% PEI. Nonspecific binding is determined by the addition of 100-fold excess of unlabeled homologous ligand, and is generally 20% of total binding. The binding reaction is terminated by rapid filtration onto 1% PEI pretreated GF/C filters using a Brandel Harvestor. Filters are placed in scintillation fluid and radioactivity assessed by liquid scintillation counting.

The following examples are illustrative of the present invention but not intended to be limiting in any way.

10

### Example 1

#### N-[2R-Hydroxy-3-[[2-cyano-5-[[4-ethylcarboxyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

##### a) 2-Hydroxyl-4-bromobenzonitrile

15 A mixture of 2-fluoro-5-bromobenzonitrile (30 g, 152.3 mmole), potassium acetate (222.4 g, 228.5 mmole), and 18-crown-6 ether (60.4 g, 288.5 mmole) in MeCN (400mL) was heated at reflux in 36 h. The mixture was cooled, added 2.5 N NaOH (200 mL), stirred at RT overnight. The mixture was extracted with ether (discarded). The aqueous layer was acidified with 6N HCl, extracted with EtOAc, dried over MgSO<sub>4</sub>, concentrated, purified by  
20 flash column chromatography (40% EtOAc/Hex) to give a light yellow foam (24.45g, 81%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ 7.13 (dd, J=1.7, 8.3 Hz, 1H), 7.17 (d, J= 1.7 Hz, 1H), 7.61 (d, J= 8.3 Hz, 1H).

##### b) Ethyl-4-[[3-hydroxyl-4-cyano]phenyl]benzoate

25 A mixture of Example 1a (3.0 g, 1.52 mmole), p-carboxylbenzene boronic acid (3.02g 1.82mmole), (Ph<sub>3</sub>P)<sub>4</sub>Pd (0.88g, 0.76 mmole), and 2M Na<sub>2</sub>CO<sub>3</sub> (38mL, 7.6mmole) in toluene/EtOH (60 mL, 4:1) was heated at reflux in 24h. The mixture was cooled, and the layers were separated. The aqueous layer was extracted with ether (discarded), acidified with 6N HCl. The tan solid (3.6g, 99%) was filtered, dried, dissolved in EtOH, and added  
30 4M HCl in p-dioxane (20mL). The resulting mixture was heated at reflux in 24h. The mixture was cooled, concentrated, taken up in H<sub>2</sub>O, stirred, filtered, and dried the off white solid (3.75g, 85%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ 1.32 (t, J= 7.1 Hz, 3H), 4.34 (q, J=

7.1 Hz, 2H), 7.29 (s, 1H), 7.31 (d, J= 8.3 Hz, 1H), 7.73 (d, J= 8.3 Hz, 1H), 7.76 (d, J= 8.3 Hz, 2H), 8.06 (d, J= 8.3 Hz, 2H).

c) Ethyl-4-[[3-[[R-glycidyl]oxyl]methyl-4-cyano]phenyl]benzoate

- 5 A mixture of Example 1b (0.71 g, 2.7 mmole), potassium carbonate (0.73g, 5.3 mmole), and R-glycidyl-3-nitrobenzenesulfonate (0.73g, 2.8 mmole) in acetone (30 mL) was heated at reflux in 24h. The mixture was cooled, concentrated, taken up in H<sub>2</sub>O, extracted with EtOAc. The organic extracts were washed with brine, dried over MgSO<sub>4</sub>, concentrated to afford an off white solid (0.7g, 82%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ
- 10 1.32 (t, J= 7.1 Hz, 3H), 2.78 (dd, J=2.6, 4.9 Hz, 1H), 2.91 (t, J= 4.9 Hz, 1H), 3.44 (m, 1H), 4.20 (dd, J= 6.5, 11.7 Hz, 1H), 4.39 (q, J= 7.1 Hz, 2H), 4.72 (dd, J= 2.6, 11.7 Hz, 1H), 7.47 (dd, J= 1.4, 8 Hz, 1H), 7.57 (d, J=1.4 Hz, 1H), 7.85 (d, J=8 Hz, 1H), 7.95 (d, J= 8.5 Hz, 1H), 8.08 (d, J= 8.5 Hz, 1H).

- 15 d) N-[2R-Hydroxy-3-[[2-cyano-5-[[4-ethylcarboxyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

- A mixture of Example 1c (0.5 g, 1.5 mmole), lithium perchlorate (0.34 g, 1.7 mmole), and 1,1-dimethyl-2-naphthyl-ethylamine (0.43 g, 3.1 mmole) in dried MeCN (15 mL) was heated at reflux in 24h. The mixture was cooled, concentrated, taken up in H<sub>2</sub>O,
- 20 extracted with CH<sub>2</sub>Cl<sub>2</sub>. The organic extracts were washed with brine, dried over MgSO<sub>4</sub>, concentrated, purified by flash column chromatography (3% MeOH/CH<sub>2</sub>Cl<sub>2</sub>) to afford an off white foam, which was dissolved in p-dioxane, and added 4M HCl in p-dioxane, concentrated, and triturated in ether to give the desired product as an off-white solid (0.65g, 80%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ 1.25 (s, 6H), 1.32 (t, J= 7.6 Hz, 3H), 3.25 (s, 3H),
- 25 3.42 (m, 2H), 4.35 (m, 3H), 6.12 (d, J= 4.6 Hz, 1H), 7.46 (m, 5H), 7.78 (s, 1H), 7.93 (m, 5H), 8.01 (d, J= 8.6 Hz, 1H), 8.10 (dd, J= 1.3, 8.6 Hz, 1H), 8.21 (s, 1H), 8.82 (t, J= 8 Hz, 1H), 9.23 (t, J= 8 Hz, 1H). MS(m/z): 523.6 (M<sup>+</sup>).

Example 2

- 30 N-[2R-Hydroxy-3-[[2-cyano-5-[[4-carboxyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

N-[2R-Hydroxy-3-[[2-cyano-5-[[4-carboxyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

To a stirred solution of Example 1d (0.3g, 0.57 mmole) in p-dioxane (10 mL) was added 2.5N NaOH, and stirred overnight. The mixture was concentrated, taken up in H<sub>2</sub>O, acidified with 2N HCl to pH= 4. The off-white solid was filtered. The solid was dissolved in MeOH and added 4M HCl in p-dioxane, concentrated to give an off-white solid (0.28 g, 100%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ1.25 (s, 6H), 3.12 (s, 2H), 3.25 (m, 4H), 4.35 (s, 2H), 7.45 (m, 4H), 7.80 (m, 6H), 8.05 (m, 3H), 8.21 (s, 1H). MS(m/z): 495.4 (M<sup>+</sup>).

10

Example 3

N-[2R-Hydroxy-3-[[2-cyano-5-[[2-ethoxycarbonyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

a) 2-[[3-hydroxy]-4-cyano]phenyl]benzaldehyde

A mixture of Example 1a (1.0 g, 5.05 mmole), 2-formylbenzene boronic acid (0.91g 6.06 mmole), (Ph<sub>3</sub>P)<sub>4</sub>Pd (0.3 g, 0.26 mmole), and 2M Na<sub>2</sub>CO<sub>3</sub> (10 mL, 25.3 mmole) in toluene/EtOH (20 mL, 4:1) was heated at reflux in 24h. The mixture was cooled, and the layers were separated. The aqueous layer was extracted with ether (discarded), acidified with 6N HCl. The tan solid (1.1 g, 99%) was filtered, dried. <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ7.31 (s, 1H), 7.34 (d, J= 8.3 Hz, 1H), 7.73 (m, 2H), 7.96 (m, 2H), 10.1 (s, 1H), 11.35 (s, 1H).

20

b) Ethyl-2-[[3-hydroxy]-4-cyano]phenyl]benzoate

A mixture of Example 3a (1.1 g, 5.02 mmole), MnO<sub>2</sub> (2.18 g, 25.1 mmole), and KCN (0.07 g, 1.01 mmole) in EtOH (20 mL) was stirred at RT in 24h. The solid was filtered, and the filtrate was concentrated, taken up in H<sub>2</sub>O, extracted with EtOAc. The organic extracts were washed with brine, dried over MgSO<sub>4</sub>, concentrated and purified by flash column chromatography (40% EtOAc/Hex) to give an off white solid (1.3g, 85%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ1.15 (t, J= 7 Hz, 3H), 4.12 (q, J= 7 Hz, 2H), 6.87 (m, 2H), 7.41 (dd, J= 1.3, 7.6 Hz, 1H), 7.55 (t, J= 7.6 Hz, 1H), 7.65 (m, 2H), 7.79 (dd, J= 1.3, 7.6 Hz, 1H), 11.2 (s, 1H).

30

c) Ethyl-2-[[3-[[R-glycidyl]oxyl]methyl]-4-cyano]phenyl]benzoate

Following the procedure in Example 1c, the title compound was obtained as a pale yellow solid (0.85 g, 87%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ1.12 (t, J= 7.1 Hz, 3H), 2.78

(dd, J= 2.6, 4.9 Hz, 1H), 2.91 (t, J= 4.9 Hz, 1H), 3.44 (m, 1H), 4.05 (m, 3H), 4.65 (dd, J= 2.6, 11.7 Hz, 1H), 6.95 (dd, J= 1.3, 7.6 Hz, 1H), 7.25 (s, 1H), 7.45 (d, J= 7.6 Hz, 1H), 7.65 (t, J= 7.6 Hz, 1H), 7.72 (t, J= 7.6 Hz, 1H), 7.76 (d, J= 7.6 Hz, 1H), 7.83 (d, J= 7.6 Hz, 1H).

5 d) N-[2R-Hydroxy-3-[[2-cyano-5-[[2-ethoxycarbonylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

Following the procedure in Example 1d, the title compound was obtained as an orange solid (0.65g, 81%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ1.12 (t, J=7.6 Hz, 3H), 1.23 (s, 6H), 2.89 (m, 4H), 3.42 (s, 2H), 3.98 (s, 1H), 4.12 (q, J= 7.6 Hz, 2H), 4.23 (m, 2H), 6.98  
10 (d, J= 8 Hz, 1H), 7.21 (s, 1H), 7.45 (d, J= 7.6 Hz, 1H), 7.53 (m, 3H), 7.62 (t, J= 8 Hz, 1H), 7.75 (m, 2H), 7.85 (m, 5H). MS(m/z): 523.4 (M<sup>+</sup>)

Example 4

15 N-[2R-Hydroxy-3-[[2-cyano-5-[[2-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

Following the procedure in Example 1e, compound 4d was converted to the title compound and obtained as an off-white solid (0.05g, 69%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ1.23 (s, 6H), 2.89 (m, 4H), 3.42 (s, 2H), 3.98 (s, 1H), 4.23 (m, 2H), 6.98 (d, J= 8 Hz, 1H), 7.21 (s, 1H), 7.45 (d, J= 7.6 Hz, 1H), 7.53 (m, 3H), 7.62 (t, J= 8 Hz, 1H), 7.75 (m,  
20 2H), 7.85 (m, 5H). MS(m/z): 495.4 (M<sup>+</sup>)

Example 5

N-[2R-Hydroxy-3-[[2-cyano-4-[[4-carbethoxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

25 a) 2-Hydroxy-5-bromobenzonitrile:

To a stirred, cooled (-20°C) solution of 2-cyanophenol (30 g, 252 mmole) in dried MeCN (400 mL) was added HBF<sub>4</sub>·Et<sub>2</sub>O (45 g, 277.1 mmole), and N-bromosuccinimide (53.8 g, 302.3 mmole). After addition was completed, the mixture was warmed to RT, and stirred in 4h. The mixture was cooled and quenched by 50% aqueous NaHSO<sub>3</sub>. The  
30 mixture was concentrated to removed excess of MeCN. The off-white solid thus obtained was filtered and dried by air (42.4 g, 85%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ6.99 (d, J= 8.9 Hz, 1H), 7.67 (dd, J= 2.5, 8.9 Hz, 1H), 7.88 (d, J= 2.5 Hz, 1H).



b) 2-[[R-Glycidyl]oxo]-5-bromobenzonitrile:

A mixture of Example 5a (5g, 25.3 mmole), potassium carbonate (5.3g, 37.9 mmole), and R-glycidyl-3-nitrobenzenesulfonate (6.9 g, 26.5 mmole) in acetone (150 mL) was heated at reflux for 24h. The mixture was cooled, concentrated, taken up in H<sub>2</sub>O, extracted with EtOAc. The organic extracts were washed with brine, dried over MgSO<sub>4</sub>, concentrated to afford an off white solid (0.7g, 82%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ2.74 (dd, J=2.6, 5.0 Hz, 1H), 2.88 (t, J=5 Hz, 1H), 3.38 (m, 1H), 4.02 (dd, J=6.4, 11.6 Hz, 1H), 4.58 (dd, J=2.6, 11.6 Hz, 1H), 7.22 (d, J= 9.1 Hz, 1H), 7.78 (dd, J= 2.5, 9.1 Hz, 1H), 8.05 (d, J= 2.5 Hz, 1H).

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c) N-[2R-Hydroxy-3-[[2-cyano-4-[4-bromophenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine

Following the procedure in Example 1d, the title compound was prepared as a yellow foam (9.2g, 75%). <sup>1</sup>H-NMR (300MHz, CDCl<sub>3</sub>): δ1.14 (s, 3H), 1.15 (s, 3H), 2.47 (s, 2H), 2.98 (m, 3H), 3.02 (dd, J= 4.6, 12.1 Hz, 1H), 3.98 (m, 1H), 4.09 (d, J= 4.6 Hz, 2H), 6.82 (d, J= 8.8 Hz, 1H), 7.31 (dd, J= 2.6, 8.4 Hz, 1H), 7.45 (m, 2H), 7.61 (m, 3H), 7.79 (m, 3H). MS(m/z): 455.4 (M<sup>+</sup>).

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d) N-[2R-Hydroxy-3-[[2-cyano-4-[[4-ethylcarboxyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

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A mixture of Example 5c (0.4 g, 0.88 mmole), p-carboxylbenzeneboronic acid (0.18 g, 1.06 mmole), (Ph<sub>3</sub>P)<sub>4</sub>Pd, and 2M Na<sub>2</sub>CO<sub>3</sub> (1.8 mL, 3.6 mmole) in toluene/EtOH (10 mL, 4:1) was heated at reflux in 24h. The mixture was cooled, and layers were separated. The aqueous layer was extracted with EtOAc (discarded), acidified with 6N HCl. The tan solid was filtered, dried by air. The solid was stirred in EtOH, and added 4M HCl in p-dioxane. The resulting mixture was heated at reflux in 24h. The mixture was cooled concentrated, taken up in H<sub>2</sub>O, neutralized by 2.5N NaOH, extracted with CH<sub>2</sub>Cl<sub>2</sub>. The organic extracts were dried, concentrated, and purified by flash column chromatography (3% MeOH/CH<sub>2</sub>Cl<sub>2</sub>) to afford an off-white foam, which was dissolved in p-dioxane and added 4M HCl, concentrated, triturated in ether to give an off-white solid (0.34g, 70%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ1.25 (s, 6H), 1.32 (t, J= 7.6 Hz, 3H), 3.25 (s, 3H), 3.42 (m, 2H), 4.35 (m, 3H), 6.12 (d, J= 4.6 Hz, 1H), 7.46 (m, 5H), 7.78 (s, 1H), 7.92 (m, 5H), 8.01 (d, J= 8.6 Hz, 1H), 8.10 (dd, J= 1.3, 8.6 Hz, 1H), 8.21 (s, 1H), 8.82 (t, J= 8 Hz, 1H), 9.22 (t, J= 8 Hz, 1H). MS(m/z): 523.6 (M<sup>+</sup>).

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Example 6N-[2R-Hydroxy-3-[[2-cyano-4-[4-carboxylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

5        Following the Example 1e, the title compound was prepared as an off white solid (0.06g, 55%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ 1.25 (s, 6H), 3.12 (s, 2H), 3.25 (m, 4H), 4.35 (s, 2H), 7.45 (m, 4H), 7.80 (m, 6H), 8.05 (m, 3H), 8.21 (s, 1H). MS(m/z): 495.4 (M<sup>+</sup>).

Example 7

10    N-[2R-Hydroxy-3-[[2-cyano-4-[2-formylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)

Following the procedure in Example 5d, the title compound was prepared as an off white solid (0.06g, 70%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ 1.32 (s, 6H), 3.21 (s, 2H), 3.42 (m, 2H), 4.42 (m, 3H), 6.11 (s, 1H), 7.55 (m, 4H), 7.62 (t, J= 8 Hz, 1H), 7.81 (m, 3H), 7.97 (m, 6H), 8.82 (t, J= 7.6 Hz, 1H), 9.12 (t, J= 7.6 Hz, 1H), 9.92 (s, 1H). MS(m/z): 479.5 (M<sup>+</sup>).

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Example 8N-[2R-Hydroxy-3-[[2-cyano-4-[3-formylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

20        Following the procedure in Example 5d, the title compound was prepared as a tan solid (0.06g, 72%). <sup>1</sup>H-NMR (300MHz, CDCl<sub>3</sub>): δ 1.14 (s, 3H), 1.16 (s, 3H), 2.92 (s, 2H), 2.98 (dd, J= 6.8, 12.1 Hz, 1H), 3.15 (dd, J= 4.8, 12.1 Hz, 1H), 4.07 (m, 1H), 4.20 (d, J= 4.8 Hz, 2H), 7.11 (d, J= 8.6 Hz, 1H), 7.36 (dd, J= 1.7, 8.4 Hz, 1H), 7.44 (m, 2H), 7.64 (m, 2H), 7.78 (m, 6H), 7.90 (dd, J= 1.7, 8.4 Hz, 1H), 8.02 (s, 1H), 10.1 (s, 1H). MS(m/z): 479.5 (M<sup>+</sup>).

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Example 9N-[2R-Hydroxy-3-[[2-cyano-4-[2-hydroxymethylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride

30        To a stirred solution of Example 4a (0.1g, 0.21 mmole) in ethanol (5 mL) was added NaBH<sub>4</sub> (0.031g, 0.84 mmole). After stirring at RT in 1/2h, the mixture was quenched by 1N HCl, extracted with CH<sub>2</sub>Cl<sub>2</sub>. The organic layers was extracted and was over MgSO<sub>4</sub>, concentrated, purified by flash column chromatography (7% MeOH/CH<sub>2</sub>Cl<sub>2</sub>) to give a colorless oil, which was dissolved in p-dioxane and added 4M HCl in p-dioxane, concentrated, and triturated in ether to afford an off-white solid (0.55g, 60%). <sup>1</sup>H-NMR (300MHz, CDCl<sub>3</sub>): δ 1.14 (s, 3H), 1.16 (s, 3H), 2.89 (d, J= 2.9 Hz, 2H), 2.95 (dd, J=

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6.8, 12.1 Hz, 1H), 3.05 (dd, J = 4.8, 12.1 Hz, 1H), 4.05 (m, 1H), 4.15 (d, J = 4.8 Hz, 2H), 4.80 (s, 2H), 7.05 (d, J = 8.6 Hz, 1H), 7.45 (m, 6H), 7.60 (s, 1H), 7.72 (s, 1H), 7.81 (m, 5H). MS(m/z): 481.4 (M<sup>+</sup>).

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**Example 10****N-[2R-Hydroxy-3-[[2-cyano-4-[[3-hydroxymethyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride**

Following the procedure in Example 6, the title compound was prepared as a white solid (0.1g, 67%). <sup>1</sup>H-NMR (300MHz, CDCl<sub>3</sub>): δ 1.14 (s, 3H), 1.16 (s, 3H), 2.89 (d, J = 2.9 Hz, 2H), 2.95 (dd, J = 6.8, 12.1 Hz, 1H), 3.05 (dd, J = 4.8, 12.1 Hz, 1H), 4.05 (m, 1H), 4.15 (d, J = 4.8 Hz, 2H), 4.80 (s, 2H), 7.05 (d, J = 8.6 Hz, 1H), 7.45 (m, 6H), 7.60 (s, 1H), 7.72 (s, 1H), 7.81 (m, 5H). MS(m/z): 481.4 (M<sup>+</sup>).

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**Example 11****N-[2R-Hydroxy-3-[[2-cyano-4-[[3-ethoxycarbonyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride**

Following the procedure in Example 2, the title compound was prepared as an off white solid (0.050g, 79%). <sup>1</sup>H-NMR (300MHz, CDCl<sub>3</sub>): δ 1.14 (s, 3H), 1.16 (s, 3H), 1.38 (t, J = 7.1 Hz, 3H), 2.98 (s, 2H), 3.02 (dd, J = 6.8, 12.1 Hz, 1H), 3.18 (dd, J = 4.8, 12.1 Hz, 1H), 4.05 (m, 1H), 4.18 (d, J = 4.8 Hz, 1H), 4.45 (q, J = 7.1 Hz, 2H), 7.09 (d, J = 8.5 Hz, 1H), 7.32 (d, J = 8.5 Hz, 1H), 7.42 (m, 2H), 7.51 (t, J = 8.5 Hz, 1H), 7.75 (m, 7H), 8.1 (d, J = 8.5 Hz, 1H), 8.19 (s, 1H). MS(m/z): 523.6 (M<sup>+</sup>).

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**Example 12****N-[2R-Hydroxy-3-[[2-cyano-4-[[3-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride**

Following the procedure in Example 1, the title compound was prepared as an off-white solid (0.100g, 79%). <sup>1</sup>H-NMR (300MHz, DMSO-d<sub>6</sub>): δ 1.14 (s, 3H), 1.16 (s, 3H), 2.98 (s, 2H), 3.0 (dd, J = 6.8, 12.1 Hz, 1H), 3.15 (dd, J = 4.8, 12.1 Hz, 1H), 4.1 (m, 1H), 4.31 (d, J = 4.8 Hz, 1H), 7.4 (m, 4H), 7.6 (t, J = 8.5 Hz, 1H), 7.72 (s, 1H), 7.83 (m, 4H), 7.98 (d, J = 8.5 Hz, 2H), 8.1 (s, 1H), 8.21 (s, 1H). MS(m/z): 495.5 (M<sup>+</sup>).

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**Example 13****N-[2R-Hydroxy-3-[[2-cyano-4-[[2-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride**

Following the procedure in Example 1, the title compound was prepared as a tan solid (0.065g, 55%). <sup>1</sup>H-NMR (300 MHz, DMSO-d<sub>6</sub>): δ 1.23 (s, 6H), 2.89 (m, 4H), 3.42 (s,

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2H), 3.98 (s, 1H), 4.23 (m, 2H), 6.98 (d, J=8 Hz, 1H), 7.21 (s, 1H), 7.45 (d, J= 7.6 Hz, 1H), 7.53 (m, 3H), 7.62 (t, J= 8 Hz, 1H), 7.75 (m, 2H), 7.85 (m, 5H). MS(m/z): 495.4 (M<sup>+</sup>).

Formulations for pharmaceutical use incorporating compounds of the present invention can be prepared in various forms and with numerous excipients. Examples of such formulations are given below.

#### Example 14

##### Inhalant Formulation

A compound of Formula (I) (1 mg to 100 mg) is aerosolized from a metered dose inhaler to deliver the desired amount of drug per use.

##### Tablet Formulation

Tablets/Ingredients	Per Tablet
1. Active ingredient (Cmp. of Formula(I))	40 mg
2. Corn Starch	20 mg
3. Alginic acid	20 mg
4. Sodium Alginate	20 mg
5. Mg stearate	13 mg

##### Procedure for tablet formulation

Ingredients 1, 2, 3 and 4 are blended in a suitable mixer/blender. Sufficient water is added portion-wise to the blend with careful mixing after each addition until the mass is of a consistency to permit its conversion to wet granules. The wet mass is converted to granules by passing it through an oscillating granulator using a No. 8 mesh (2.38 mm) screen. The wet granules are then dried in an oven at 140°F (60°C) until dry. The dry granules are lubricated with ingredient No. 5, and the lubricated granules are compressed on a suitable tablet press.

#### Example 15

##### Parenteral Formulation

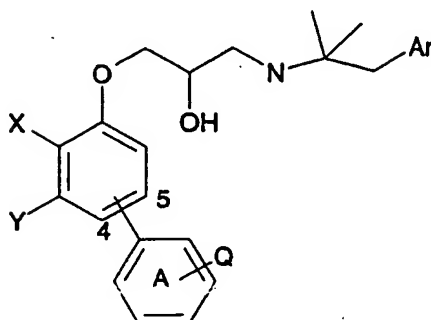
A pharmaceutical composition for parenteral administration is prepared by dissolving an appropriate amount of a compound of Formula (I) in polyethylene glycol with heating. This solution is then diluted with water for injections (to 100 ml). The solution is then rendered sterile by filtration through a 0.22 micron membrane filter and sealed in sterile containers.

All publications, including but not limited to patents and patent applications cited in this specification are herein incorporated by reference as if each individual publication

were specifically and individually indicated to be incorporated by reference as though fully set forth.

What is claimed is:

1. A compound selected from Formula (I) hereinbelow:



Formula (I)

wherein:

A represents an aryl ring that is attached at position 4 or 5, as indicated;

X is selected from the group consisting of CN, NO<sub>2</sub>, Cl, F, and H;

Y is selected from the group consisting of Cl, F, Br, I and H;

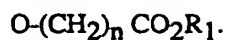
Q is selected from the group consisting of H, R<sub>1</sub>, SO<sub>2</sub>R<sub>1</sub>, R<sub>1</sub>C(O)OR'<sub>1</sub>, tetrazole, CH<sub>2</sub>OH, COH, SO<sub>2</sub>NR<sub>1</sub>R'<sub>1</sub>, C(O)NR<sub>1</sub>R'<sub>1</sub>, and NR<sub>1</sub>SO<sub>2</sub>R'<sub>1</sub>, wherein R<sub>1</sub> and R'<sub>1</sub> are independently selected from the group consisting of hydrogen, C<sub>1-4</sub> alkyl, and optionally substituted alkyl,

or R<sub>1</sub> and R'<sub>1</sub> together form a 3 to 7 membered optionally substituted heterocyclic ring; and Ar is phenyl or naphthyl, heteroaryl or fused heteroaryl, substituted or unsubstituted, such that the hetero-ring may contain N, O or S and may be aromatic, dihydro or tetrahydro.

2. A compound according to claim 1 wherein any alkyl substituents are selected from the group consisting of CN, aryl, CO<sub>2</sub>R, CO<sub>2</sub>NHR, OH, OR, CO, NH<sub>2</sub>, halo, CF<sub>3</sub>, OCF<sub>3</sub> and NO<sub>2</sub>, wherein R represents H, C<sub>1-4</sub> alkyl, C<sub>3-6</sub> cycloalkyl, C<sub>2-5</sub> alkenyl, C<sub>2-5</sub> alkynyl, heterocycloalkyl, aryl or aryl C<sub>1-4</sub> alkyl.

3. A compound according to claim 1 wherein any phenyl or naphthyl substituents are selected from the group consisting of OH, halo, CO<sub>2</sub>R<sub>1</sub>, C<sub>1-4</sub> alkyl, C<sub>1-4</sub> alkoxy, C<sub>3-6</sub> cycloalkyl, OSO<sub>2</sub>R<sub>1</sub>, CN, NO<sub>2</sub>, OCF<sub>3</sub>, CF<sub>3</sub>, CH<sub>2</sub>CF<sub>3</sub>, (CH<sub>2</sub>)<sub>n</sub> CO<sub>2</sub>H, (CH<sub>2</sub>)<sub>n</sub> CO<sub>2</sub>R<sub>1</sub>, O-(CH<sub>2</sub>)<sub>n</sub> and CO<sub>2</sub>R<sub>1</sub>, wherein n is an integer from 0 to 3 and R<sub>1</sub> represents C<sub>1-4</sub> alkyl, C<sub>3-6</sub> cycloalkyl or C<sub>3-6</sub> cycloalkyl.

4. A compound according to claim 3 wherein any heteroaryl substituents are selected from the group consisting of OH, OCH<sub>3</sub>, CH(CH<sub>3</sub>)<sub>2</sub>, halo, CO<sub>2</sub>R<sub>1</sub>, C<sub>1-4</sub> alkyl, C<sub>1-4</sub> alkoxy, C<sub>3-6</sub> cycloalkyl, CN, NO<sub>2</sub>, OCF<sub>3</sub>, CF<sub>3</sub>, CH<sub>2</sub>CF<sub>3</sub>, (CH<sub>2</sub>)<sub>n</sub> CO<sub>2</sub>R<sub>1</sub>, and



5. A compound according to claim 1 selected from the group consisting of:  
 N-[2R-Hydroxy-3-[2-cyano-5-[2-carbetoxyphenyl]phenoxy]propyl]-  
 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[2-cyano-5-[4-carbetoxyphenyl]phenoxy]propyl]-  
 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-5-[[4-carboxy]phenyl]phenoxy]propyl]-  
 1,1-dimethyl-2-[naphthyl]ethylamine hydrochloride;  
 10 N-[2R-Hydroxy-3-[[2-cyano-5-[2-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[4-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[carbetoxyphenyl]phenoxy]propyl]-  
 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 15 N-[2R-Hydroxy-3-[[2-cyano-4-[2-formylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[3-formylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;  
 20 N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[hydroxymethyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[[2-hydroxymethylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[[ethyl]carboxyl]]phenyl]phenoxy]propyl]-  
 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 25 N-[2R-Hydroxy-3-[2-cyano-4-[3-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride; and  
 N-[2R-Hydroxy-3-[2-cyano-4-(2-carboxyphenyl)phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride.
- 30 6. A compound according to claim 5 selected from the group consisting of:  
 N-[2R-Hydroxy-3-[2-cyano-5-[2-carbetoxyphenyl]phenoxy]propyl]-  
 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 N-[2R-Hydroxy-3-[2-cyano-5-[4-carbetoxyphenyl]phenoxy]propyl]-  
 1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;  
 35 N-[2R-Hydroxy-3-[[2-cyano-5-[[4-carboxy]phenyl]phenoxy]propyl]-  
 1,1-dimethyl-2-[naphthyl]ethylamine hydrochloride;

- N-[2R-Hydroxy-3-[[2-cyano-4-[4-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[carbetoxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- 5 N-[2R-Hydroxy-3-[[2-cyano-4-[2-formylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[3-formylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[hydroxymethyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;
- 10 N-[2R-Hydroxy-3-[[2-cyano-4-[[2-hydroxymethylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[[ethyl]carboxyl]]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- 15 N-[2R-Hydroxy-3-[2-cyano-4-[3-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride; and
- N-[2R-Hydroxy-3-[2-cyano-4-(2-carboxyphenyl)phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride.
7. A compound according to claim 6 selected from the group consisting of:
- 20 N-[2R-Hydroxy-3-[2-cyano-5-[2-carbetoxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[2-cyano-5-[4-carbetoxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-5-[[4-carboxy]phenyl]phenoxy]propyl]-1,1-dimethyl-2-[naphthyl]ethylamine hydrochloride;
- 25 N-[2R-Hydroxy-3-[[2-cyano-4-[4-carboxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[carbetoxyphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;
- 30 N-[2R-Hydroxy-3-[[2-cyano-4-[2-formylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[3-formylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;
- N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[hydroxymethyl]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(naphthyl)ethylamine hydrochloride;
- 35 N-[2R-Hydroxy-3-[[2-cyano-4-[[2-hydroxymethylphenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;



N-[2R-Hydroxy-3-[[2-cyano-4-[[3-[[ethyl]carboxyl]]phenyl]phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride;

N-[2R-Hydroxy-3-[2-cyano-4-[3-carboxyphenyl]phenoxy]propyl]]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride; and

5 N-[2R-Hydroxy-3-[2-cyano-4-(2-carboxyphenyl)phenoxy]propyl]-1,1-dimethyl-2-(2-naphthyl)ethylamine hydrochloride.

8. A method of antagonizing a calcium receptor which comprises administering to a subject in need thereof, an effective amount of a compound according to claim 1.

9. A method of treating a disease or disorder characterized by an abnormal bone or  
10 mineral homeostasis, which comprises administering to a subject in need of treatment thereof an effective amount of a compound of claim 1.

10. A method according to claim 9 wherein the bone or mineral disease or disorder is selected from the group consisting of osteosarcoma, periodontal disease, fracture healing, osteoarthritis, rheumatoid arthritis, Paget's disease, humoral hypercalcemia, malignancy  
15 and osteoporosis.

11. A method according to claim 10 wherein the bone or mineral disease or disorder is osteoporosis.

12. A method of increasing serum parathyroid levels which comprises administering to a subject in need of treatment an effective amount of a compound of claim 1.

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# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US00/02676

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A61K 31/41, 31/135; C07D 257/04; C07C 255/00

US CL : 514/381, 652; 548/254; 558/422

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 514/381, 652; 548/254; 558/422

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CAS ONLINE

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,P	US 5,922,763 A (HIMMELSBACH et al) 13 July 1999, entire document	1-7
A,P	US 5,965,592 A (BUHLMAYER et al) 12 October 1999, entire document	1-7

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	X	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E* earlier document published on or after the international filing date	Y	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	A	document member of the same patent family
*O* document referring to an oral disclosure, use, exhibition or other means		
*P* document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

03 MAY 2000

Date of mailing of the international search report

13 JUN 2000

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